WHAT IS CLAIMED IS:

~~1. The method of using a scan-deflectable~~ ultraviolet laser beam to correct an astigmatic condition of an eye, by selectively ablating the external surface of the cornea, which comprises focusing the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, and scanning the laser beam over the locally involved area with beam-exposure flux at a level at which resultant corneal-tissue ablation per scan is to an elemental depth which is but a fraction of desired maximum ablation into the stroma region of the cornea, the scanning of said area being in a pattern to impact the cornea with greatest and substantially uniform density of laser-beam exposure per unit area along a central line of symmetry across said area and through the optical center, said pattern being further characterized by laser-beam exposure density decreasing smoothly with increasing lateral offset on both sides of said central line of symmetry, said central line of symmetry being oriented to accord with a pre-ascertained determination of the cylindrical-axis orientation of the astigmatic condition.

2. The method of claim 1, in which said pattern has a limiting circular perimeter which is centered on the optical axis of the eye.

3. The method of claim 1, in which the pattern of scan action is one of scanning successive lapped areas of progressively changing width, distributed symmetrically between opposed parallel sides which are parallel to and at equal and opposite offset from the central line of symmetry.

4. The method of claim 1, in which the laser is a pulsed laser.

5. The method of claim 1, in which the laser is a continuous-wave laser.

6. The method of claim 1, in which the pattern of area scanning is two-axis rectilineal, wherein line scanning in a first-axis component is oriented to accord with said cylindrical-axis orientation, and wherein scan-line depression in a second-axis component is substantially orthogonal to said cylindrical-axis orientation.

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7. Astigmatism-correcting apparatus for operation upon a limited central area of the external surface of the cornea of an eye, comprising laser means having a chassis and producing an output beam in the ultraviolet portion of the electromagnetic spectrum and characterized by a spot which at eye impingement is small relative to said central area, scan-deflection means positioned for deflection of said beam in a limited field about a central axis, body-engageable

means for steadying one eye of the patient with respect to said chassis and with the central area of the cornea centered on the central axis of scan deflection of said beam, said scan-deflection means having X-Y coordinates of deflection for area coverage at least within the perimeter of said central area, adjustable means for angular selection of the orientation of said coordinates to position one to the exclusion of the other of said coordinates in oriented alignment with the astigmatism axis of the eye to be operated upon, and means including a microprocessor for establishing a series of different centrally related perimeter limits of rectangular-area scan action within the perimeter of said central area and for coordinating the operation of said scan-deflection means in a controlled program of limitation of one area scan within one perimeter limit before repeating such coordination within the next-successive perimeter limit in the series, the successively scanned areas being of varying width and symmetrical about a central axis aligned with said astigmatism axis, said laser means including means for adjusting beam-exposure flux to a level at which resultant corneal-tissue ablation per unit time is to an ascertained elemental depth which is but a fraction of desired maximum depth of ablation into the stroma region of the cornea, whereby ablative penetration to said maximum depth is the cumulative result of plural area scans of each of a succession of different but overlapping rectangular areas.

8. Astigmatism apparatus according to claim 7, and including means for effectively limiting to the perimeter of said central area the component of scan in said one-coordinate orientation.

9. Sculpture apparatus for reduction of an ascertained astigmatic condition in the central area of the external surface of the cornea of an eye of a patient, comprising laser means having a chassis and producing an output beam in the ultraviolet portion of the electromagnetic spectrum and characterized by a spot which at eye impingement is small compared to said area, scan-deflection means positioned for deflection of said beam in a limited field about a central axis, body-engageable means for steadying one eye of the patient with respect to said chassis and with the central area of the cornea centered on the central axis of scan deflection of said beam, said scan-deflection means having two coordinates of deflection for area coverage within the perimeter of said central area, said laser including means for adjusting beam-exposure flux to a level at which resultant corneal-tissue ablation per unit time is to an ascertained elemental depth which is but a fraction of desired maximum depth of ablation into the stroma region of the cornea, and means including a microprocessor for coordinating the operation of said scan-deflection means in a controlled program of area coverage to establish greatest cumulative beam exposure along the alignment of the

central axis of symmetry of the ascertained astigmatic condition, with cumulative beam exposure decreasing smoothly as a function of increasing lateral offset on both sides of said central axis of symmetry.

10. The method of using an ultraviolet laser beam to change optical properties of an eye having both astigmatic and myopia errors, by selectively ablating the external surface of the cornea, which method comprises confining the laser beam to a projected spot which is small compared to the area containing said errors, adjusting the intensity of laser-beam projection to a limited level at which resultant corneal-tissue ablation per unit time is to an ascertained elemental depth which is but a fraction of a maximum ablation depth, said maximum ablation depth having been predetermined as necessary to reduce to substantially zero the cylindrical curvature responsible for the astigmatism, scanning said spot over a plurality of elongate rectangular-area scans which are centered along an elongate line of symmetry oriented on the corneal diameter which corresponds to the axis of astigmatic error, said rectangular-area scans being of varying width on opposite lateral sides of said line of symmetry, whereby an astigmatism-correcting change may be effected in the cornea to thereby leave essentially only spherical error to be corrected; then subjecting the laser beam to a series of scans of circular areas centered on and within the maximum area of the cornea to

be subjected to myopia-correction ablation, said series being characterized by varying outer radius, whereby a myopia-correcting change may be effected in the curvature of the cornea.

11. The method of using an ultraviolet laser beam to change optical properties of an eye having both astigmatic and hyperopia errors, by selectively ablating the external surface of the cornea, which method comprises confining the laser beam to a projected spot which is small compared to the area containing said errors, adjusting the intensity of laser-beam projection to a limited level at which resultant cornea-tissue ablation per unit time is to an ascertained elemental depth which is but a fraction of a maximum ablation depth, said maximum ablation depth having been predetermined as necessary to reduce to substantially zero the cylindrical curvature responsible for the astigmatism, scanning said spot over a plurality of elongate rectangular-area scans which are centered along an elongate line of symmetry oriented on the corneal diameter which corresponds to the axis of astigmatic error, said rectangular-area scans being of varying width on opposite lateral sides of said line of symmetry, whereby an astigmatism-correcting change may be effected in the cornea to thereby leave essentially only spherical error to be corrected; then subjecting the laser beam to a series of scans of circular annuli centered on corneal area to be subjected to hyperopia-

correcting ablation, said series being characterized by constant outer radius equal to that of said corneal area and being further characterized by varying inner radius of the annuli of successive area scans, whereby a hyperopia-correcting change may be effected in the curvature of the cornea.

12. Sculpture apparatus for operation upon the external surface of the cornea of an eye of a patient, comprising laser means having a chassis and producing an output beam in the ultraviolet portion of the electromagnetic spectrum, scan-deflection means positioned for deflection of said beam, and body-engageable means for steadying one eye of the patient with respect to said chassis and with a corneal portion of said one eye within a field traversed by scan deflection of said beam, said scan-deflection means being operative to produce a circular sweep of beam travel about the center of the cornea and including further means for changing the radius of circular sweep, and means including a microprocessor for coordinating the operation of said scan-deflection means with that of said further means in a controlled program of successive circular sweeps of said beam with at least one discrete radius of circular sweep.

13. Apparatus according to claim 12, in which said last-defined means further coordinates effective deactivation of said output beam in periods of changing radius of circular sweep.

14. Apparatus according to claim 12, in which said last-defined means coordinates effective deactivation of said output beam at predetermined angular intervals within each circular sweep, thereby operating upon the eye in a regular succession of angularly spaced circular arcs.

15. Apparatus according to claim 14, in which said last-defined means coordinates effective deactivation of said output beam at predetermined angular intervals within each circular sweep at each of plural radii of circular sweep.

16. Apparatus according to claim 15, in which the angular intervals at one radius are in staggered interlace with the angular intervals at an adjacent radius of circular sweep.

17. Apparatus according to claim 12, wherein said laser means includes means for adjusting the beam-exposure flux to a level at which resultant corneal-tissue ablation per unit time is to an ascertained elemental depth which is but a fraction of desired maximum depth of ablation into the stroma region of the cornea, whereby ablative penetration to said maximum depth is the cumulative result of plural scans of each locus of circular sweep.

18. The method of using a scan-deflectable ultraviolet laser beam to selectively ablate the external surface of a cornea, which comprises limiting the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, and scanning the laser beam in an angularly spaced plurality of arcuate sweeps within the locally involved area with beam-exposure flux at a level at which resultant corneal-tissue ablation per sweep is to an ascertained elemental depth which is but a fraction of desired maximum ablation into the stroma region of the cornea, said arcuate sweeps being between predetermined angular limits within a full circle at predetermined radius, and such scanning continuing with repetition of radial sweeps until reaching a predetermined depth of ablation for each arcuate sweep, whereby a keratotomy is performed upon the cornea.

19. The method of claim 18, wherein said predetermined radius is one of a plurality of discrete radii of arcuate sweeps.

20. The method of claim 19, wherein the predetermined angular limits of arcuate sweeps at one radius are in angularly staggered interlace with the angular limits of arcuate sweeps at a different one of said radii.

21. The method of using a scan-deflectable ultraviolet laser beam to perform a keratotomy by

selective ablation of the external surface of a cornea, which comprises limiting the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, activating said beam and radially sweeping the activated beam at each of an angularly spaced plurality of predetermined radial orientations within said area, the radial sweeps at said orientations being between predetermined inner and outer radial limits, and arcuately sweeping said beam in periods of angular indexing from one to another of radial sweeps at said predetermined radial orientations, the beam-exposure flux being limited to assure ablative photodecomposition to the extent of only partial penetration of the cornea.

22. The method of using a scan-deflectable ultraviolet laser beam to perform a keratotomy which will correct an astigmatic correction by selective ablation of the external surface of a cornea, which comprises limiting the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, activating said beam and radially sweeping the activated beam at each of at least a pair of diametrically opposed locations on an orientation selected to accord with the axis of the astigmatic condition to be corrected, the radial sweeps at said orientation being between predetermined inner and outer radial limits, the beam-exposure flux being limited to assure ablative photodecomposition to the extent of only partial penetration of the cornea.

23. The method of using a scan-deflectable ultraviolet laser beam to perform a keratotomy which will correct an astigmatic correction by selective ablation of the external surface of a cornea, which comprises limiting the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, activating said beam and radially sweeping the activated beam to execute a radial incision at each of at least a pair of diametrically opposed locations on an orientation selected to accord with the axis of the astigmatic condition to be corrected, the radial sweeps at said orientation being between predetermined inner and outer radial limits, and sweeping said beam transversely of each radial incision and with substantial symmetry of offset with respect to each radial incision, the beam-exposure flux being limited to assure ablative photodecomposition to the extent of only partial penetration of the cornea.

24. The method of using a scan-deflectable ultraviolet laser beam to perform a keratotomy which will correct a condition of combined astigmatism and myopia by selective ablation of the external surface of a cornea, which comprises limiting the laser beam to an elemental spot size which is but a small fraction of the area of the cornea to be subjected to ablation, activating said beam and radially sweeping the activated beam to execute a radial incision at each of an angularly spaced plurality of predetermined radial orientations within said area, the radial sweeps at said

orientations being between predetermined inner and outer radial limits, at least a pair of said orientations being diametrically opposed and selected to accord with the axis of the astigmatism to be corrected, and sweeping said beam transversely of each of the radial incisions of said pair, the transverse sweeps being with substantial symmetry of offset with respect to the respective radial incisions of said pair, the beam-exposure flux being limited to assure ablative photodecomposition to the extent of only partial ~~penetration of the cornea.~~

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